AQA Biology A-level

6.4 - Homeostasis is the maintenance of a stable internal environment

Flashcards

What is homeostasis?

What is homeostasis?

Internal environment is maintained within set limits around an optimum.

Why is it important that core temperature remains stable?

Why is it important that core temperature remains stable?

Maintain stable rate of enzyme-controlled reactions & prevent damage to membranes.

Temperature too low = enzyme & substrate molecules have insufficient kinetic energy.

Temperature too high = enzymes denature.

Why is is important that blood pH remains stable?

Why is it important that blood pH remains stable?

Maintain stable rate of enzyme-controlled reactions (& optimum conditions for other proteins).

Acidic pH = H^+ ions interact with H-bonds & ionic bonds in tertiary structure of enzymes → shape of active site changes so no ES complexes form.

Why is it important that blood glucose concentration remains stable?

Why is it important that blood glucose concentration remains stable?

- Maintain constant **blood water potential**: prevent osmotic lysis / crenation of cells.
- Maintain constant **concentration of respiratory substrate**: organism maintains constant level of activity regardless of environmental conditions.

Define negative and positive feedback.

Define negative and positive feedback.

Negative feedback: self-regulatory mechanisms return internal environment to optimum when there is a fluctuation.

Positive feedback: a fluctuation triggers changes that result in an even greater deviation from the normal level.

Outline the general stages involved in negative feedback.

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Receptors detect deviation → coordinator → corrective mechanism by effector → receptors detect that conditions have returned to normal.

Suggest why separate negative feedback mechanisms control fluctuations in different directions.

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Provides more control, especially in case of ‘overcorrection’, which would lead to a deviation in the opposite direction from the original one.

Suggest why coordinators analyse inputs from several receptors before sending an impulse to effectors.

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- Receptors may send conflicting information.
- Optimum response may require multiple types of effector.

Why is there a time lag between hormone production and response by an effector?

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It takes time to:

- produce hormone
- transport hormone in the blood
- cause required change to the target protein

Name the factors that affect blood glucose concentration.

Name the factors that affect blood glucose concentration.

- Amount of carbohydrate digested from diet.
- Rate of glycogenolysis.
- Rate of gluconeogenesis.

Define glycogenesis, glycogenolysis and gluconeogenesis.

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Glycogenesis: liver converts glucose into the storage polymer glycogen.

Glycogenolysis: liver hydrolyses glycogen into glucose which can diffuse into blood.

Gluconeogenesis: liver converts glycerol & amino acids into glucose.

Outline the role of glucagon when blood glucose concentration decreases.

Outline the role of glucagon when blood glucose concentration decreases.

1. **α cells** in **Islets of Langerhans** in **pancreas** detect decrease & secrete **glucagon** into bloodstream.
2. Glucagon binds to surface receptors on **liver** cells & activates enzymes for **glycogenolysis** & **gluconeogenesis**.
3. Glucose diffuses from liver into bloodstream.

Outline the role of adrenaline when blood glucose concentration decreases.

Outline the role of adrenaline when blood glucose concentration decreases.

1. **Adrenal glands** produce **adrenaline**. It binds to surface receptors on liver cells & activates enzymes for **glycogenolysis**.
2. Glucose diffuses from liver into bloodstream.

Outline what happens when blood glucose concentration increases.

Outline what happens when blood glucose concentration increases.

1. **β cells** in **Islets of Langerhans** in **pancreas** detect increase & secrete **insulin** into bloodstream.
2. Insulin binds to surface receptors on target cells to:

a) increase cellular glucose uptake
b) activate enzymes for **glycogenesis** (liver & muscles)
c) stimulate adipose tissue to synthesise fat

Describe how insulin leads to a decrease in blood glucose concentration.

Describe how insulin leads to a decrease in blood glucose concentration.

- Increases permeability of cells to glucose.
- Increases glucose concentration gradient.
- Triggers inhibition of enzymes for glycogenolysis.

How does insulin increase permeability of cells to glucose?

How does insulin increase permeability of cells to glucose?

- Increases number of glucose carrier proteins.
- Triggers conformational change which opens glucose carrier proteins.

How does insulin increase the glucose concentration gradient?

How does insulin increase the glucose concentration gradient?

- Activates enzymes for glycogenesis in liver & muscles.
- Stimulates fat synthesis in adipose tissue.

Use the secondary messenger model to explain how glucagon and adrenaline work.

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1. Hormone-receptor complex forms.
2. Conformational change to receptor activates G-protein.
3. Activates **adenylate cyclase**, which converts ATP to **cyclic AMP** (cAMP).
4. cAMP activates **protein kinase A** pathway.
5. Results in **glycogenolysis**.

Explain the causes of Type 1 diabetes and how it can be controlled.

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Body cannot produce insulin e.g. due to autoimmune response which attacks β cells of Islets of Langerhans.

Treat by injecting insulin.

Explain the causes of Type 2 diabetes and how it can be controlled.

Explain the causes of Type 2 diabetes and how it can be controlled.

Glycoprotein receptors are damaged or become less responsive to insulin.

Strong positive correlation with poor diet / obesity.

Treat by controlling diet and exercise regime.

Name some signs and symptoms of diabetes.

Name some signs and symptoms of diabetes.

- High blood glucose concentration
- Glucose in urine
- Polyuria
- Polyphagia
- Polydipsia
- Blurred vision
- Sudden weight loss
- Blurred vision

Suggest how a student could produce a desired concentration of glucose solution from a stock solution.

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Volume of stock solution = required concentration x final volume needed / concentration of stock solution.

Volume of distilled water = final volume needed - volume of stock solution.

Outline how colorimetry could be used to identify the glucose concentration in a sample.

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1. Benedict's test on solutions of known glucose concentration. Use colorimeter to record absorbance.
2. Plot calibration curve: absorbance (y-axis), glucose concentration (x-axis).
3. Benedict's test on unknown sample. Use calibration curve to read glucose concentration at its absorbance value.

Define osmoregulation.

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Control of blood water potential via homeostatic mechanisms.

Describe the gross structure of a mammalian kidney.

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Fibrous capsule: protects kidney.

Cortex: outer region consists of Bowman's capsules, convoluted tubules, blood vessels.

Medulla: inner region consists of collecting ducts, loops of Henle, blood vessels.

Renal pelvis: cavity collects urine into ureter.

Ureter: tube carries urine to bladder.

Renal artery: supplies kidney with oxygenated blood.

Renal vein: returns deoxygenated blood from kidney to heart.

Describe the structure of a nephron.

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Describe the structure of a nephron.

Bowman's capsule at start of nephron: cup-shaped, surrounds glomerulus, inner layer of podocytes.

Proximal convoluted tubule (PCT): series of loops surrounded by capillaries, walls made of epithelial cells with microvilli.

Loop of Henle: hairpin loop extends from cortex into medulla.

Distal convoluted tubule : similar to PCT but fewer capillaries.

Collecting duct: DCT from several nephrons empty into collecting duct, which leads into pelvis of kidney.

Describe the blood vessels associated with a nephron.

Describe the blood vessels associated with a nephron.

Wide afferent arteriole from **renal artery** enters renal capsule & forms **glomerulus**: branched knot of capillaries which combine to form **narrow efferent arteriole.**

Efferent arteriole branches to form **capillary network** that surrounds tubules.

Explain how glomerular filtrate is formed.

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Ultrafiltration in Bowman's capsule.

High **hydrostatic pressure in glomerulus** forces small molecules (urea, water, glucose, mineral ions) out of capillary fenestrations AGAINST osmotic gradient.

Basement membrane acts as filter. Blood cells & large molecules e.g. proteins remain in capillary.

How are cells of the Bowman’s capsule adapted for ultrafiltration?

How are cells of the Bowman's capsule adapted for ultrafiltration?

- Fenestrations between epithelial cells of capillaries.
- Fluid can pass between & under folded membrane of podocytes.

State what happens during selective reabsorption and where it occurs.

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Useful molecules from glomerular filtrate e.g. glucose are reabsorbed into the blood.

Occurs in proximal convoluted tubule.

Outline the transport processes involved in selective reabsorption.

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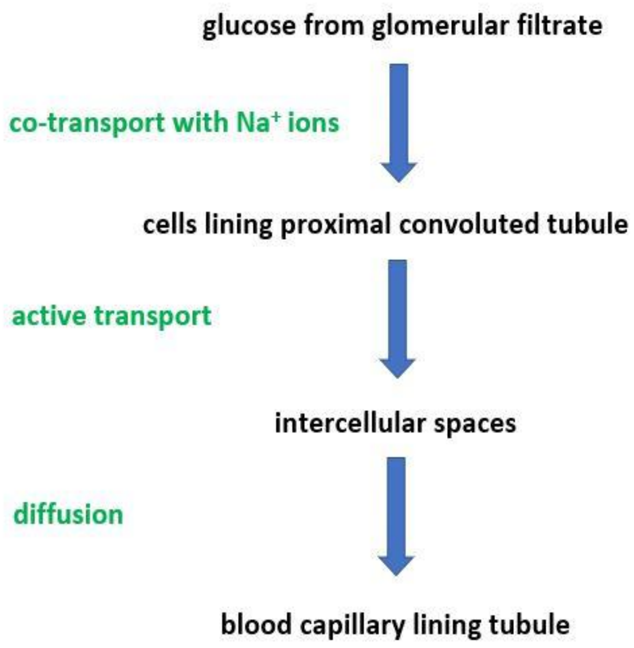

How are cells in the proximal convoluted tubule adapted for selective reabsorption?

How are cells in the proximal convoluted tubule adapted for selective reabsorption?

- **Microvilli**: large surface area for co-transporter proteins.
- Many **mitochondria**: ATP for active transport of glucose into intercellular spaces.
- **folded basal membrane**: large surface area.

What happens in the loop of Henle?

What happens in the loop of Henle?

1. Active transport of Na^+ & Cl^- out of **ascending limb.**
2. Water potential of **interstitial fluid** decreases.
3. Osmosis of water out of **descending limb** (ascending limb is impermeable to water).
4. Water potential of **filtrate** decreases going down descending limb: lowest in **medullary region**, highest at top of ascending limb.

Explain the role of the distal convoluted tubule.

Explain the role of the distal convoluted tubule.

Reabsorption:

a) of water via osmosis
b) of ions via active transport

permeability of walls is determined by action of hormones.

Explain the role of the collecting duct.

Explain the role of the collecting duct.

Reabsorption of water from filtrate into interstitial fluid via osmosis through aquaporins.

Explain why it is important to maintain an Na^+ gradient.

Explain why it is important to maintain an Na^+ gradient.

Countercurrent multiplier: filtrate in collecting ducts is always beside an area of interstitial fluid that has a lower water potential.

Maintains water potential gradient for maximum reabsorption of water.

What might cause blood water potential to change?

What might cause blood water potential to change?

- level of water intake
- level of ion intake in diet
- level of ions used in metabolic processes or excreted
- sweating

Explain the role of the hypothalamus in osmoregulation.

Explain the role of the hypothalamus in osmoregulation.

1. Osmosis of water out of **osmoreceptors** in hypothalamus causes them to shrink.
2. This triggers hypothalamus to produce more **antidiuretic hormone (ADH)**.

Explain the role of the posterior pituitary gland in osmoregulation.

Explain the role of the posterior pituitary gland in osmoregulation.

Stores and secretes the ADH produced by the hypothalamus.

Explain the role of ADH in osmoregulation.

Explain the role of ADH in osmoregulation.

1. Makes cells lining collecting duct more permeable to water:
- Binds to receptor → activates phosphorylase → vesicles with aquaporins on membrane fuse with cell-surface membrane.

2. Makes cells lining collecting duct more permeable to urea:
- water potential in interstitial fluid decreases.
- more water reabsorbed = more concentrated urine.